I. REMARKS

The Office Action dated December 18, 2002 and references cited therein have been carefully reviewed.

A. THE PENDING CLAIMS

Applicants have noted that the Examiner continues to not acknowledge that claims 71-77 are pending in the above-identified patent application. As stated in the response filed on September 25, 2002, claims 71-77 were filed with a preliminary amendment on May 28, 2002. Indeed, the preliminary amendment added new claims 40-77. Applicants again request consideration of these claims.

B. THE ELECTED CLAIMS

Applicants, in the response filed on September 25, 2002, identified claims 29-33, 36-43, 45-48, 53-56, 58-60, 62, 63, 66-70, and 75-77 as being associated with this alleged species. The Examiner identified in the Office Action that claims 22-25, 27, 28, 32, 35, 37, 44, 47, 49-52, 61 and 64 were withdrawn from consideration. Applicants submit that claims 32, 37 and 47 were improperly withdrawn from consideration.

Dependent claim 32, which depends on claim 31, includes the limitation that the diamond shaped air gap is substantially symmetrical. FIGURE 8 illustrates a diamond shaped air gap that is substantially symmetrical. Applicants submit that claim 32 falls within the elected species.

Dependent claim 37, which depends on claim 29, includes the limitation that the air gap has a configuration that causes the inductance of the choke to gradually vary over a current range in an inverse relationship with a weld current. FIGURE 8 illustrates an air gap configuration that causes

the inductance of the choke to gradually vary over a current range in an inverse relationship with a weld current. Applicants submit that claim 37 falls within the elected species.

Dependent claim 47, which depends on claim 46, includes the limitation that the inductance of the choke at least partially varies generally inversely proportional to the weld current. FIGURE 8 illustrates an air gap configuration that causes the inductance of the choke to gradually vary over a current range in an inverse relationship with a weld current. Applicants submit that claim 47 falls within the elected species.

Applicants request consideration of claims 32, 37 and 47 in the above-identified patent application.

C. GENERIC CLAIMS

Applicants, in the response filed on September 25, 2002, identified claim 58 as a generic claim. The Examiner correctly asserted that claims 58 is not generic to claims 22-25, 27, 28 and 32. Independent claim 58 is generic to all the claims dependent therefrom, namely claims 59-77. Independent claim 29 is generic to all the claims dependent therefrom, namely claims 30-33 and 36-39. Finally, independent claim 40 is generic to all the claims dependent therefrom, namely claims 41-56.

D. NEW CLAIMS

Applicants have canceled claims 22-25, 27, 28, 39, 50, 52, 72 and 74 without prejudice, and added new claims 78-91. Applicants submit that the newly added claims are generic to and/or are directed to the elected species.

II. SUMMARY OF THE INVENTION

The present invention discloses a novel output choke for a D.C. arc welder. The output choke of the present invention is designed to overcome the limitations of past chokes concerning size, saturation and inflection points. As disclosed in the Background of the Invention (Page 1, ln. 6 - Page 2, ln. 23) and in Figures 2-5, standard large output chokes for arc welders that have a fixed air gap in the core worked well until the output choke experienced high weld currents and core saturation, thereby drastically reducing the inductance. Standard practice to overcome this problem during the welding process was to enlarge the width of the air gap in the core to provide constant inductance over the anticipated operating current range of the welder. As a result, standard output chokes for arc welders were sized and selected for a particular operating current range for a particular welding operation. The width of the air gap of standard output chokes for arc welders was enlarged to reduce the amount of inductance for a particular size of the choke, resulting in the output choke having to be made quite large with large wires to carry the weld current and a large cross sectioned core to prevent saturation. Such output chokes are expensive and drastically increase the weight of the welder.

One prior art output choke design developed to attempt to overcome the problems associated with standard constant width air gap output chokes was a choke having an air gap that included two or three different widths. This alternative prior art output choke produced a high inductance until the smallest air gap saturated. Thereafter, a lower inductance would be realized until the next larger air gap saturated. By using this alternative prior art choke design, the size of the output choke could be reduced and the range of current controlled by the choke could be increased; however, the choke produced one or more inflection points. As a result, when the feed speed of the electrode or arc

length changed to operate in the area of the inflection points, the D.C. welder oscillated about the saturation or inflection points, thereby causing an unstable welding operation. Consequently, the use of multiple stepped output chokes could not be used in arc welders, since the weld current varied too much to operate on the saturation knee of the output choke. Therefore, output chokes having a constant width air gap remain in use for D.C. arc welders.

The novel output choke of the present invention is specifically designed for use in a D.C. arc welder and solves the problems of weight, cost and welding inconsistencies experienced by standard large chokes having a fixed air gap or smaller chokes having a stepped air gap. (Page 3, lns. 2-4). The output choke includes a high permeability core with an area having a cross-sectional shape with two spaced edges and an air gap, wherein the air gap has a gradually converging width between the two edges. (Page 3, lns. 5-7). In one configuration, the air gap of the output choke has a diamond shape; however, other shapes can be used such as, but not limited to, an oval shape or other curvilinear shapes. (Page 3, lns. 8-9; Page 4, lns. 1-3). When a diamond shaped arc gap is used, the diamond shape can be substantially symmetrical (Figures 8 and 14), or non-symmetrical (Figure 12).

The gradually converging air gap width of the output choke produces an inductance in the output circuit of a D.C. welder which gradually varies over the current range in an inverse relationship with the weld current. (Page 3, lns. 9-12; Figure 7). Consequently, as the welding current increases, the inductance decreases in a continuous manner without any discontinuity or steps. As illustrated in Figures 2-5 and disclosed in the specification, prior art standard chokes have a current-inductance curve that is a straight line relationship between current and inductance, which is substantially constant until the choke becomes saturated and an inflection point occurs. Thereafter, the value is lowered and remains substantially constant until the next inflection point is

reached. Consequently, the current-inductance curve of a standard choke does not have a straight line relationship between the current and inductance over a wide current range, nor does the current-inductance curve vary in an inversely proportional relationship to the weld current over a wide current range. The novel choke of the present invention overcomes these past problems of prior art chokes. The weld current is never at a saturation point for the novel output choke, nor does it operate on the saturation knee, thus there is no oscillation of the power to the weld. (Page 3, lns. 12-15). Thus, the output choke of the present invention provides current control over a wide range of weld currents without oscillating or without the need for a large output choke (page 3, lns. 16-18), and without saturation in the air gap, which saturation can cause undesired inflection points that can result in hunting or oscillation of the welder at certain wire speeds and arc lengths. (Page 4, lns. 7-11). By using the output choke of the present invention, a robust welder is obtained that can handle changes, and up to 5-10 volts with arc length changes, without causing instability of the arc. (Page 3, lns. 15-16). The output choke thereby provides current control over a wide range of weld currents without oscillating or without the need for a large output choke. (Page 3, lns. 16-18).

The output choke is specifically designed for use in D.C. arc welders which require a relatively large choke. In such D.C. arc welders, the output choke must be able to handle currents exceeding 50 amperes. Typically, the output choke is designed to handle currents of about 100-500 amperes while still maintaining an unsaturated core. (Page 5, lns. 1-8).

Several non-limiting output choke configurations of the present invention are described in detail on pages 10-12 of the specification. As shown in Figures 6, 8, 12 and 14, the air gap of the output choke is generally diamond shaped. Figures 6, 8 and 14 illustrate the air gap as being substantially symmetrical. Figure 12 discloses the air gap of the output choke as being a generally

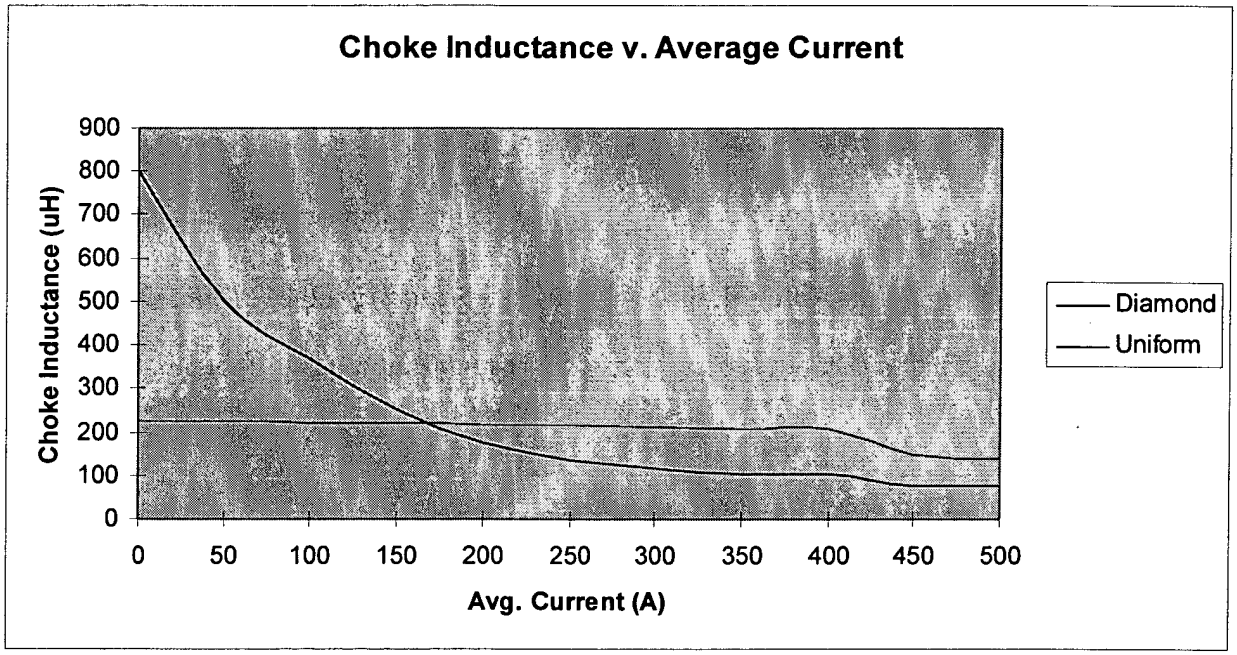
skewed diamond shape non-symmetrical. Figures 9 and 10 disclose the air gap of the output choke as being generally curvilinear shaped. In each of these air gap configurations, the inductance gradually changes in an inverse relationship with the weld current without saturation in the air gap or any inflection points as shown in Figures 7 and 11.

In each of these output choke designs, the output choke includes a high permeability core 52. The core includes first and second pole pieces (Figure 9 - 300, 302; Figure 10 - 320, 322; Figure 12 - 350, 352; Figure 14 - 402, 404. Note, Figure 8 does not include specific numbers for the two pole pieces), and an inductance controlling air gap (Figure 8 - 58; Figure 9 - 314; Figure 10 - 334; Figure 12 - 338; Figure 14 - 400). The air gap is defined by an end surface on the first and second pole pieces (Figure 8 - 54, 56; Figure 9 - 304, 306; Figure 10 - 324, 326; Figure 12 - 360, 362, 364, 366. Note, Figure 14 does not include specific numbers for the end surfaces on the first and second pole pieces). The end surfaces of the first and second pole pieces face one another and at least a portion of the end surfaces are spaced apart from one another to form the air gap therebetween, as shown in Figures 6, 8-10, 12 and 14. The end surfaces of the first and second pole pieces include corresponding outer edges (Figure 8 - 54a, 54b, 56a, 56b; Figure 14 - 406, 408. Note, Figures 9, 10 and 12 do not include specific numbers for the outer edges of end surfaces on the first and second pole pieces). The outer edges are spaced apart substantially the same distance. Figures 6, 8, 9, 10 and 12 illustrate the outer edges as being spaced apart at some positive distance from one another. Figure 14 illustrates the outer edges as being spaced zero distance apart from one another. In each of these Figures, the outer edges are spaced apart substantially the same distance.

The end surfaces of the first and second pole pieces also include a middle portion positioned between the outer edges. A portion of the middle portion of one pole piece is illustrated by letters

a-d in Figure 8. Figures 6, 9, 10 and 12 do not include specific numbers for the middle portion of the end surfaces on the first and second pole pieces. Figures 6, 8, 9, 10 and 12 illustrate that at least a portion of the middle portions of said end surfaces are spaced apart a distance greater than the distance between the outer edges of the end surfaces. As illustrated in Figures 7 and 11 and as disclosed on page 11, lines 2-5, 9-11, 17-20 and page 12, lines 17-20, the air gap of the output chokes illustrated in Figures 6, 8, 9, 10 and 12 results in an inductance that gradually changes with an output current of the welder without saturation in the air gap, thereby eliminating inflection points during operation of the welder.

The novel choke design enables higher inductance at low to mid current ranges, and lowers the inductance at higher current ranges, thereby resulting in better overall welding characteristics. A comparison of the inductance of a standard prior art choke and a novel choke in accordance with the present invention is illustrated in the following graph:



The graph illustrates the inductance versus the current of two chokes. The chokes are identical except for the shape of the air gap. The Diamond line represents a novel choke having a diamond shaped gap in accordance with the present invention. The Uniform line represents a standard prior art choke having a uniform spaced gap. Typically, it takes two complete straight gapped chokes in series to achieve the same inductance that is achieved by the novel choke at about 100 amperes, as illustrated in the graph. An additional benefit of the novel choke is that during the starting of an arc welder, the current rises and the inductance reduces, thus facilitating in the stabilization of the startup of the arc.

As illustrated in the graph, there are no jump discontinuities throughout the welding current range. This is a result of the gradual and continuous gap variation of the novel choke. Such jump discontinuities would be experienced with stepped gap design, which jump discontinuities destabilize the arc.

It has been found that the higher inductance at low to mid range currents that are achieved by use of the novel choke results in superior welds on stainless steel materials as compared with welds formed by arc welders using standard choke designs. Another benefit of using the novel choke of the present invention is that only half the capacitance is required in the output cap bank to achieve the same arc stability that was previously required when using standard choke designs. Furthermore, equivalent performance has been found when using five (5) turns on the novel choke design with thirty (30) turns on a standard choke design. As a result, the same inductance within a given current range can be obtained with less iron and/or number of conductor turns when using the novel choke design as compared to a standard choke design. This result creates significant advantages as to size, weight and cost when using the novel choke design of the present invention.

THE SECTION 112 REJECTION

Claims 40-43, 46, 48, 53-56, 58-60, 62, 63, 66-68 and 70 were rejected under 35 U.S.C. §112(2) as being indefinite for failing to particularly point out and distinctly claim the invention.

The Examiner requested clarification of the structure and arrangement in claims 40 and 58 with respect to "inner edge", "the outer edge" and the middle portions." Applicants have amended claims 40, 54 and 58 to remove the term "inner edge." Applicants submit that claims 40 and 58 are definite with respect to the terms "the outer edge" and "the middle portions."

The Examiner also requested clarification of the limitation in claims 46 and 68 that requires that at least a portion of the middle portion of the corresponding end surfaces is spaced apart at a varying distance to substantially gradually vary the inductance of the choke over a current range. Applicants have amended claims 46 and 68 to now state "at least a portion of the middle portion of said corresponding end surfaces being spaced apart at a varying distance to substantially gradually vary the inductance of said choke over substantially a complete current range of said choke." This limitation is illustrated in FIGURES 7 and 11. A non-gradual variance of inductance of the choke over substantially a complete current range of the choke is illustrated in FIGURES 3 and 5.

The Examiner also requested clarification concerning claims 58 and 59. Applicants have amended these claims to clarify the scope of such claims.

Applicants submit that all the claims pending in the above-identified patent application are in proper form pursuant to 35 U.S.C. §112.

THE SECTION 103 REJECTION

Claims 29-31, 33, 38-43, 46, 48, 53-56, 58-60, 62, 63, 67, 68 and 70 were rejected under 35 U.S.C. §103(a) as being unpatentable over Bergman in view of Ward. Claims 36, 45 and 66 were

rejected under 35 U.S.C. §103(a) as being unpatentable over Bergman in view of Ward and further in view of Saitoh.

The Examiner asserted that Bergman teaches the invention except for the specific structure of pole piece/air gap. As the Examiner is aware, the specific structure of pole piece/air gap fora choke used in a D.C. arc welder is the principal inventive feature of Applicants' invention. The Examiner attempts to overcome the deficiency of Bergman by citing Ward. Ward has nothing to do with chokes, much less chokes for arc welders. Ward discloses a testing apparatus for testing electrical insulation. One skilled in the art of welding would not look to the teachings of Ward to find a solution to the problem of saturation of a choke used in a D.C. arc welder. Ward is clearly non-analogous art. In addition, the combination of Bergman with Ward is classic hindsight reconstruction of Applicants' invention. The Examiner has not referenced any passage in Ward that pertains to a choke for use in a welder. The Examiner also has not referenced any passage in Ward that pertains to choke saturation. Consequently, there is no motivation to one skilled in the art to combine any teaching of Ward with any teaching of Bergman. Finally, Ward does not disclose, teach of suggest a substantially V-shaped air gap. The air gap disclosed in Ward is substantially circular, not V-shaped. For at least the reasons set forth above, Bergman in combination with Ward does not make obvious any of the claims pending in the above-identified patent application.

The combination of Saitoh with Bergman and Ward does not make obvious claims 29, 40 and 58. As set forth above, Ward is 1) non-analogous art, 2) includes no teachings as to chokes for arc welders, and 3) contains to teachings that would motivate one skilled in the art to combine any teachings of Ward with any teachings in Bergman. Consequently, any rejection that includes the combination of Ward cannot support an obviousness rejection of any of the pending claims. As to

the specific teachings of Saitoh, the Examiner continues to mis-cite such teachings. Saitoh does not teach an air gap. The surface irregularities of the core in Saitoh are caused by poor manufacturing techniques. Saitoh merely discloses how to overcome the problems associated with such surface irregularities so that when the two cores are placed together, there is effectively **no** air gap. This is achieved by inserting a highly permeable material on the surface irregularities to thereby close any air gap that would have formed when the cores are positioned together. The teachings of Saitoh have nothing to do with the present invention. Indeed, the teachings of Saitoh teach away from the present invention.

Applicants submit the claims presently pending in the above-identified patent application are in condition for allowance and a notice to that effect is earnestly solicited. Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page(s) are captioned **"VERSION WITH MARKINGS TO SHOW CHANGES MADE."**

Respectfully submitted,
FAY, SHARPE, FAGAN, MINNICH & McKEE

By:_____

ROBERT V. VICKERS
Reg. No. 19,504
1100 Superior Avenue, Seventh Floor
Cleveland, Ohio 44114-2579
Telephone: (216) 861-5582
Facsimile: (216) 241-1666

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 22-25, 27, 28, 39, 50, 52, 72 and 74 have been canceled without prejudice.

Claims 29-31, 33, 40, 46, 54, 58, 59, 62, 64, 68, and 77 have been amended as follows:

29. (Amended) An output choke for a D.C. arc welder having an inductance comprising a high permeability core having first and second pole pieces, an inductance controlling air gap, and at least one winding for conducting welding current, said first and second pole pieces each having and end surface, said air gap defined between said end surfaces of said first and second pole pieces, each end surfaces including two outer edges and [an intermediate area] a middle portion positioned there between, at least one of said [intermediate areas] middle portions being substantially V-shaped, said air gap having a width between said [intermediate areas] middle portions of said first and second pole pieces that is greater than a width between either of said outer edges of said first and second pole pieces, said air gap having a configuration which results in said inductance of said choke gradually changing with an output current of the welder without saturation in said air gap thereby eliminating inflection points during operation of said welder, said at least one winding and said core having a size to prevent saturation at a weld current of at least about 100 amperes.

30. (Amended) The output choke as defined in claim 29, wherein both [intermediate areas] said middle portions being substantially V-shaped.

31. (Twice Amended) The output choke as defined in claim 29, wherein said air gap is substantially diamond shaped.

33. (Amended) The output choke as defined in claim 29, wherein said [intermediate areas] middle portions of said end surfaces of said first and second pole pieces having substantially the same shape.

40. (Twice Amended) An output choke for a D.C. arc welder having an inductance and adapted to include at least one winding for conducting current, said output choke comprising a high permeability core having first and second pole pieces and an inductance controlling air gap, said first and second pole pieces each having [and] an end surface, said air gap defined between said end surfaces of said first and second pole pieces, each of said end surfaces including [inner and] outer edges and a middle portion positioned there between, at least one of said middle portions being substantially V-shaped, said air gap having a width between said middle portions of said end surfaces of said first and second pole pieces that is greater than a width between at least one pair of said [inner edges or] outer edges of said end surfaces of said first and second pole pieces, said air gap having a configuration which results in said inductance of said choke changing with an output current of the welder without saturation in said air gap thereby substantially eliminating inflection points during operation of said welder.

46. (Amended) The output choke as defined in claim 40, wherein said at least a portion of the middle portion of said corresponding end surfaces being spaced apart at a varying distance to substantially gradually vary the inductance of said choke over substantially a complete current range of said choke.

54. (Amended) The output choke as defined in claim 53, wherein said [inner and] outer edges of said end surfaces of said first and second pole pieces being spaced apart at substantially the same distance.

58. (Twice Amended) An output choke for a D.C. arc welder having an inductance and adapted to include at least one winding for conducting current, said output choke comprising a high permeability core having first and second pole pieces and an inductance controlling air gap, said air gap defined by an end surface on said first and second pole pieces, at least a portion of said end surfaces of said first and second pole pieces being spaced from one another and facing one another, said end surfaces of said first and second pole pieces each having [an inner and] outer edges and a middle portion between said [inner and] outer edges, at least a portion of the middle portion of said corresponding end surfaces being spaced apart at a varying distance to vary the inductance of said choke over a current range, said air gap having a converging width that at least partially converges toward said [inner and] outer edges, at least a portion of said air gap having a width that is greater than the spacing between either the [inner and] outer edges of said first and second pole pieces, said middle portions having a configuration to substantially prevent inflection points along a saturation curve of said choke.

59. (Amended) The output choke as defined in claim 58, wherein [said end surfaces of said pole pieces each having a middle portion positioned between said outer edges,] said middle portions having substantially non-perpendicular oriented surfaces.

62. (Amended)The output choke as defined in claim 58, wherein at least one of said middle portions being substantially V-shaped.

64. (Amended) The output choke as defined in claim 58, wherein at least one of said middle portions being substantially arcuate shaped.

68. (Amended) The output choke as defined in claim 58, wherein said at least a portion of the middle portion of said corresponding end surfaces being spaced apart at a varying distance to substantially gradually vary the inductance of said choke over substantially a complete current range of said choke.

77. (Amended) The output choke as defined in claim 58, wherein said output choke adapted to charge a capacitor.

New claims 78-91 have been added.